1985

SUBMITTAL NO. 4

EXECUTIVE SUMMARY

FINAL SUBMITTAL: INCREMENTS A, B, F, & G

FORT STORY

ENERGY ENGINEERING ANALYSIS PROGRAM

CONTRACT NO DACA65/81/C/0021

FOR THE

NORFOLK DISTRICT CORPS OF ENGINEERS

PREPARED BY

MMM DESIGN GROUP

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
ATTENTION OF: TR-I Library

17 Sep 1997

Based on SOW, these Energy Studies are unclassified/unlimited. Distribution A. Approved for public release.

Marie Wakefield,
Librarian Engineering

TABLE OF CONTENTS

			PAGE
I.	REPORT NARRATIVE (separately bound)		
	1.	INTRODUCTION	
		1.1 PURPOSE OF THE STUDY	1/1
		1.2 ORGANIZATION OF THE EEA REPORT	1/2
		1.3 DESCRIPTION OF THE FACILITY	1/3
		1.4 APPROACH TO ANALYSIS	1/13
	2.	HISTORICAL ENERGY USAGE	
		2.1 BASEWIDE ENERGY CONSUMPTION: FY 1975 THROUGH FY 1980	2/1
		2.2 ENERGY END USE	2/16
	3.	BASEWIDE ENERGY SAVINGS PLAN	
		3.1 INTRODUCTION	3/1
		3.2 PAST ENERGY CONSERVATION PROJECTS	3/1
		3.3 ENERGY CONSERVATION PROJECTS UNDER CONTRACT	3/1
		3.4 EXISTING OPERATIONAL AND MAINTENANCE PROCEDURES	3/2
		3.5 DEMOLITION AND SHUTDOWN	3/2
		3.6 NEW CONSTRUCTION PROJECTS	3/2
		3.7 ANALYSIS OF ENERGY CONSERVATION OPTIONS: INCREMENTS (A),(B),(G), AND (F)	3/5
		3.8 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (A)	3/17
		3.9 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (B)	3/27
		3.10 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (G)	3/31
		3.11 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (F)	3/43
		3.12 SUMMARY OF BASEWIDE ENERGY SAVINGS PLAN	3/55

TABLE OF CONTENTS (continued)

		PAGE
II.	APPENDIX (separately bound)	
1.	REVIEW COMMENTS	1/1
1.1	SUBMITTAL NO. 1 REVIEW COMMENTS	1/2
1.2	SUBMITTAL NO. 2 REVIEW COMMENTS	1/23
1.3	SUBMITTAL NO. 3 REVIEW COMMENTS	1/29
1.4	PROJECT DOCUMENTATION SUBMITTAL REVIEW COMMENTS	1/55
2.	BUILDINGS ON BASE BY USE GROUP	2/1
3.	HISTORICAL ENERGY USAGE	3/1
3.1	MILITARY AGGREGATE STRENGTH AND OTHER POPULATION DATA	3/2
3.2	WINTERIZATON DATA	3/6
3.3	SITE UTILTIIES AND LIGHTING	3/9
3.4	ENERGY COST DATA AND UTILITY SCHEDULES	3/16
4.	FACTORS IMPACTING BASEWIDE ENERGY SAVINGS PLAN	4/1
4.1	PAST AND ONGOING ENERGY CONSERVATION PROJECTS	4/2
4.2	SYNERGY METHODOLOGY	4/5
5.	ECONOMIC COST DATA AND ESCALATION RATES	5/1
6.	COMPUTER (BLAST) MODELING	6/1
6.1	ASSUMPTIONS USED FOR BLAST	6/2
6.2	SAMPLE BLAST INPUT AND OUTPUT: BUILDING 849	6/9
7.	INCREMENT (A) AND INCREMENT (B) ENERGY CONSERVATION PROJECTS: ENERGY SAVINGS AND ECONOMIC CALCULATIONS	7/1
8.	INCREMENT (G) ENERGY CONSERVATION PROJECTS: ENERGY SAVINGS AND ECONOMIC CALCULATIONS	8/1
9.	INCREMENT (F) ENERGY CONSERVATION PROJECTS: ENERGY SAVINGS AND ECONOMIC CALCULATIONS	9/1
10.	ELECTRICAL DISTRIBUTION SYSTEM ANALYSIS	10/1
11.	REFERENCES FOR THE STUDY	11/1

TABLE OF CONTENTS (continued)

III. PROJECT DOCUMENTATION (separately bound)

1. PROJECT DOCUMENTATION: ENERGY CONSERVATION MODIFICATIONS FOR ARMY FACILITIES, FORT STORY, VIRGINIA

   1.1 PROJECT DEVELOPMENT BROCHURE
   1.2 FORMS 1391, 1391C AND DETAILED JUSTIFICATION
   1.3 ENERGY CONSERVATION INVESTMENT PROGRAM

2. PROJECT DOCUMENTATION: ENERGY CONSERVATION MODIFICATIONS FOR NAVY FACILITIES, FORT STORY, VIRGINIA

   2.1 PROJECT DEVELOPMENT BROCHURE
   2.2 FORMS 1391, 1391C AND DETAILED JUSTIFICATION
   2.3 ENERGY CONSERVATION INVESTMENT PROGRAM

3. PROJECT DOCUMENTATION: ENERGY CONSERVATION MODIFICATIONS FOR ARMY RESERVE FACILITIES, FORT STORY, VIRGINIA

   3.1 PROJECT DEVELOPMENT BROCHURE
   3.2 FORMS 1391, 1391C, AND DETAILED JUSTIFICATION
   3.3 ENERGY CONSERVATION INVESTMENT PROGRAM

4. PROJECT DOCUMENTATION: ENERGY CONSERVATION MODIFICATIONS FOR FAMILY HOUSING FACILITIES, FORT STORY, VIRGINIA

   4.1 PROJECT DEVELOPMENT BROCHURE
   4.2 FORMS 1391, 1391C, AND DETAILED JUSTIFICATION
   4.3 ENERGY CONSERVATION INVESTMENT PROGRAM

5. PROJECT DOCUMENTATION: ENERGY MANAGEMENT CONTROL SYSTEM (EMCS) FOR FORT STORY, VIRGINIA

   5.1 PROJECT DEVELOPMENT BROCHURE
   5.2 FORMS 1391, 1391C AND DETAILED JUSTIFICATION
   5.3 ENERGY CONSERVATION INVESTMENT PROGRAM

TABLE OF CONTENTS (continued)

		PAGE
IV.	EXECUTIVE SUMMARY (bound herein)	
1.	INTRODUCTION	1
1.1	OBJECTIVE	1
1.2	METHODOLOGY	1
2.	EXISTING ENERGY CONSUMPTION	2
3.	ENERGY CONSERVATION MEASURES DEVELOPED	2
3.1	INTRODUCTION	2
3.2	RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENTS (A) AND (B)	3
3.3	RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENTS (G)	3
3.4	RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENTS (F)	3
4.	ENERGY AND COST SAVINGS	4
5.	ENERGY PLAN	4

TABLE OF CONTENTS: FIGURES

		PAGE
I.	REPORT NARRATIVE (separately bound)	
1-1	MILITARY AGGREGATE STRENGTH: FY 75 THROUGH FY 83	1/5
1-2	FORT STORY POST POPULATION: FY 80	1/6
1-3	FORT STORY POST POPULATION: FY 81	1/7
1-4	MILITARY AGGREGATE STRENGTH: FY 80 AND FY 81	1/8
1-5	FORT STORY CLIMATOLOGICAL DATA	1/14
1-6	FORT STORY: BUILDING USE GROUP AREA	1/18
1-7	FORT STORY BUILDING USE GROUPS AND SPECIFIC BUILDING TYPES	1/19
1-8	FORT STORY BUILDING USE GROUPS SUMMARY	1/21
1-9	CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS	1/23
1-10	TYPICAL BUILDING SYSTEMS SUMMARY TABLE	1/26
2-1	TOTAL MBTU CONSUMPTION FY 75 THROUGH FY 80 OF #2 AND #5 FUEL OILS	2/4
2-2	TOTAL MBTU CONSTRUCTION FY80 OF #2 AND #5 FUEL OILS	2/5
2-3	TOTAL MBTY CONSUMPTION FY 75 THROUGH FY 80 OF LPG	2/6
2-4	TOTAL MBTU CONSUMPTION FY 80 OF LPG	2/7
2-5	TOTAL MBTU CONSUMPTION FY 75 THROUGH FY 80 OF ELECTRICITY	2/8
2-6	TOTAL MBTU CONSUMPTION FY 80 OF ELECTRICITY	2/9
2-7	MBTU/H DEMAND FY 80 OF ELECTRICITY	2/10
2-8	TOTAL MBTU CONSUMPTION FY 75 THROUGH FY 80	2/11
2-9	TOTAL MBTU CONSUMPTION FY 80	2/12
2-10	ANNUAL ENERGY CONSUMPTION (MBTU)	2/13
2-11	TOTAL ENERGY USE BY FUEL TYPE, FORT STORY - FY 75	2/14
2-12	TOTAL ENERGY USE BY FUEL TYPE, FORT STORY - FY 80	2/15
2-13	FUNCTIONAL ENERGY CONSUMPTION	2/18
2-14	BUILDING GROUP ENERGY USAGE 1975	2/23
2-15	BUILDING GROUP ENERGY USE - BASE YEAR 1975	2/24

TABLE OF CONTENTS: FIGURES (continued)

		PAGE
3-1	ENERGY SAVED FROM BUILDING DEMOLITION	3/3
3-2	ESTIMATED ENERGY USE OF NEW CONSTRUCTION (1981 - 1985)	3/4
3-3	PRELIMINARY MATRIX - ENERGY CONSERVATION OPTIONS	3/6
3-4	FUTURE METERING PLAN	3/54
3-5	EEA PROJECT SUMMARY	3/56
3-6	ENERGY COST PROJECTION	3/59
3-7	ENERGY PROJECTION SUMMARY	3/60

IV EXECUTIVE SUMMARY (bound herein)

1.	FORT STORY BUILDING USE GROUPS SUMMARY	6
2.	CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS	7
3.	TYPICAL BUILDING SYSTEMS SUMMARY TABLE	10
4.	BUILDING GROUP ENERGY USAGE 1975	13
5.	TOTAL MBTU CONSUMPTION FY-75 THROUGH FY-80	14
6.	ANNUAL ENERGY CONSUMPTION (MBTU)	15
7.	TOTAL ENERGY USE BY FUEL TYPE, FORT STORY - FY 1975	16
8.	TOTAL ENERGY USE BY FUEL TYPE, FORT STORY - FY 1980	17
9.	BUILDING GROUP ENERGY USE-BASE YEAR 1975	18
10.	PRELIMINARY MATRIX - ENERGY CONSERVATION OPTIONS	19
11.	EEA PROJECT SUMMARY	20
12.	ENERGY COST PROJECTION	23
13.	ENERGY PROJECTION SUMMARY	24

1. INTRODUCTION

1.1 OBJECTIVE

This is a summary of an Energy Engineering Analysis, conducted to provide a Basewide Energy Savings Plan at Fort Story, Virginia. This Plan includes recommendations for energy conservation Projects to reduce the installation's present energy consumption, as well as a description of other energy-related factors which affect consumption. It is important to note that savings figures presented in this summary can only be realized after all Projects have been implemented. MMM Design Group has developed Projects that meet the funding requirements for the D.O.D.'s Energy Conservation Investment Program. Furthermore, the recommended Projects provide compliance with the Army Facilities Energy Plan. This summary presents data relative to the following chronological period:

A. 1975 Energy Consumption (baseline).

B. 1985 Energy Use (projection).

The programmed projects developed in this analysis, along with other energy use factors described further in the Basewide Energy Savings Plan, have resulted in a 43% projected reduction in Fort Story's energy consumption by FY 1985.

This Analysis Program was conducted in accordance with the DAEN-MPE-E scope of work for Energy Engineering Analysis Program (EEAP), revised 4 May 1981. The analysis conforms with the NAOEN-MA Norfolk District Energy Conservation Investment Program (ECIP) guidance, dated 10 November 1980. Further Addenda are provided to update the analysis results in accordance with Energy Conservation Investment Program (ECIP) guidance, revised 31 December 1982.

1.2 METHODOLOGY

The Analysis methodology was based in part on an examination and study of a "sampling" of structures representative of all of the structures at Fort Story. These "sample" or "study" buildings were used to model "building use groups" which had similar architectural, mechanical, and electrical system characteristics, as well as similar functional uses. These characteristics are summarized in Figures 1, 2, and 3.

2. EXISTING ENERGY CONSUMPTION

Once these building group system characteristics were determined, they were input into the Corps of Engineers Building Loads Analysis and Systems Thermodynamics (BLAST) Program. Then, the BLAST Program parameters were manipulated in order to simulate 1975 conditions. See Building Group Energy Usage (Figure 4) for a description of energy sources, and energy use totals by building group. Finally, a total MBTU consumption record was prepared to model actual consumption between 1975 and 1980, adjusted for historic degree days, (Figures 5 and 6). These figures reflect a total consumption of 202,765 MBTU for the 1975 baseline, including energy use for buildings and all other energy consuming systems (site utilities, site lighting, etc.).

Figures 7 and 8 compare the relative percentages of fuel types used during 1975 and 1980 fiscal years. Noteworthy is the fact that fuel oil use has declined slightly, from 56% to 52% of the total energy usage. Liquid petroleum use has also declined from 2% to less than 1%. This fuel oil and LPG usage drop has been made up by electricity usage, which has increased from 41% to 47% of the total energy consumed.

Figure 9 indicates the annual source energy consumed by each of the significant building groups used in the basewide energy model. Housing is the largest user, consuming 47% of total energy, administrative the second largest consumer at 26%, and shops consume 11%. Recreation, dining facilities, and warehouses use 3%, 4%, and 7% respectively. Utilities use approximately 2%.

3. ENERGY CONSERVATION MEASURES DEVELOPED

3.1 Introduction

The tool used for initial analysis of possible new energy conservation measures or options at Fort Story was a Preliminary Matrix (Figure 10). This matrix ranked each option by building use group, and established priorities for detailed study and project development of selected options.

The separately bound "Appendix" volume of this Energy Engineering Analysis provides documentation of the back-up material developed during the course of the work. The results of the programmed energy conservation Projects are included in the separately bound volume entitled "Project Documentation." A summary of all Projects, categorized by EEA study Increment, can be found in the EEA Project Summary (Figure 11). These projects are listed in order of their E over C Ratio.

3.2 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENTS (A) AND (B)

A total of eleven (11) projects, Increments (A) and (B), qualified under ECIP criteria as programmable energy conservation projects. Included are the installation of ceiling fans for atmospheric destratification as well as noncombustable insulation for damper panels, domestic water heaters and building envelopes. Also qualifying for these Increments are the caulking and weatherstripping of building fenestration, the replacement of inefficient furnaces and street lighting, the analysis and tune-up of oil fired furnaces, the alteration of combustion controls of central steam boilers, and the installation of a basewide Energy Management Control System.

3.3 RECCOMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (G)

A total of ten (10) Projects did not meet the necessary ECIP criteria, and therefore do no appear in the Project Documentation volume of this report. These projects were subsequently classified under Increment (G). Included under this increment are the installation of storm windows, insulated overhead doors, heat pumps, timer switches for toilet room lighting and domestic water heater controls. Also included are the replacement of inefficient light fixtures, lamps and ballasts, as well as the construction of earth berms and the addition of solar domestic water heating.

3.4 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (F)

Recommendations for modifications to system operation at Fort Story, which are within the funding authority and/or management control of the Facilities Engineer, fall into five broad categories:

A. Replacement of "as-needed" system components with "state-of-the-art," high-efficiency components: Such components as electrical lamps, water system pump motors, and high-bay roll-up doors, are examples of opportunities to save energy by means of Facility Engineer selection and purchase proceedures.

B. Personnel consolidation into fewer structures in order to increase numbers of winterized buildings: This suggestion would entail coordination with the current Operations Intelligence Officer regarding scheduled building use.

C. Establishment of an Energy Management Team: Under the direction of the Facility Engineering Office, this staff would closely monitor energy consuming systems and coordinate semiannual operations and maintenance. Duties performed by this team include management of guest houses and other intermittent-use facilities, semi-annual installation of storm windows and damper panels, monitoring of thermostat settings and performance of preventative maintenance on HVAC systems.

D. Future Metering Plan: Provided for the future monitoring of electricity consumption, this plan determines the high energy use buildings on base and suggests locations for future electrical meters.

E. Other Operation and Maintenance Projects: Additional increment (F) projects include reduction of window glazing where possible, and reduction of domestic hot water temperature to DOD energy standards.

The above recommendations are discussed in more detail within the body of the Report Narrative.

4. ENERGY AND COST SAVINGS

The annual energy savings by proposed Project are given in Figure 11, along with the payback period, in years. This payback is based on the implementation of all Projects by fiscal year 1985, and uses fuel types related to each respective project. Fuel cost escallation is given from 1980 to 1985 in Figure 12, entitled "Energy Cost Projection."

For projected energy consumption and total energy savings to be realized, savings from inter-related or interdependent projects must be coordinated. Thus, the total energy savings, as shown in the Energy Projection Summary (Figure 13), is based on the assumption that all projects will be implemented by a given fiscal year (1985).

5. ENERGY PLAN

A Fort Story Basewide Energy Savings Plan, the ultimate result of this Energy Engineering Analysis, includes energy use input from the following:

A. Past Energy Conservation Projects.

B. Energy Conservation Projects Under Contract.

C. Existing Operational and Maintenance Projects.

D. Demolition and Shutdown.

E. New Construction Projects.

F. Recommended Energy Conservation Projects.

A summary of the above energy use factors is given in Figure 13, the Energy Projection Summary, with the exception of Increment G and Increment F energy savings. These latter savings are not officially programmed in this Energy Engineering Analysis; and they may not be capable of implementation in conjunction with other officially programmed ECIP Projects. The percent reductions made possible by elements of the Basewide Energy Savings Plan are also given in Figure 13.

As a result of total implementation of the Fort Story Basewide Energy Savings Plan, energy usage per square foot of above grade structure will be affected substantially. This reduction of energy usage per square foot shall equate approximately to the following:

A. FY 1975 BTU/square foot = 182,000.

B. FY 1985 BTU/square foot = 91,000.

The final result of the Basewide Energy Savings Plan, as shown in Figure 13, is the overall 43% reduction in annual energy consumption by Fiscal Year 1985.

FORT STORY BUILDING USE GROUPS SUMMARY

BUILDING USE GROUP	SUB-GROUP NO.	STUDY BUILDING NO.	WALL CODE	ROOF CODE	TOTAL SUB-GROUP SQUARE FEET	TOTAL USE GROUP SQUARE FEET
ADMINISTRATION	A-1	1030	WD	PS	119,145	
	A-2	581/1075/300	MAS	PS	22,336	
	A-3	851/811	MAS	BU	9,885	
	A-4	704/727	UG	UG	96,604	247,870
QUARTERS	B-1	811	WD	PS	245,842	
	B-2	847/849	MAS	BU	15,931	
	B-3	321/438	WD	BU	195,229	
	B-4	714	WD	PS	41,091	498,183
SHOPS	C-1	751/759/1058	WD	PS	32,887	
	C-2	804/808/1081/ 1082/1083/1088	MAS	BU	95,738	128,625
DINING	D-1	586/1016	WD	PS	46,112	46,112
WAREHOUSE	E-1	750	WD	PS	74,762	74,762
RECREATION	F-1	845	MAS	BU	30,047	30,047
MISCELLANEOUS UNHEATED	G-1	NONE	VARIES	VARIES	58,737	58,737
TOTAL BUILDING AREA (FY1980)						1,084,448

WALL CONSTRUCTION CODE: WD - WOOD FRAME OR WOOD FRAME WITH BRICK VENEER.
MAS - MASONRY BLOCK OR BRICK.
UG - UNDERGROUND CONSTRUCTION (POURED CONCRETE AND EARTH).

ROOF CONSTRUCTION CODE: PS - PITCHED SHINGLE OVER WOOD DECK.
BU - BUILT UP ROOF OVER WOOD DECK OR METAL DECK.
UG - UNDERGROUND CONSTRUCTION (POURED CONCRETE AND EARTH).

FIGURE 1

CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS

GROUP NO.	BUILD. NO.	BUILDING USE	NO. OF FLOORS	BUILDING AREA (FT.^{2})	ROOF TYPE AREA (FT.^{2})	U VALUE	WALL TYPE AREA (FT.^{2})	U VALUE	DOOR TYPE AREA (FT.^{2})	U VALUE	FLOOR TYPE PERIMETER (FT.)	U VALUE	WINDOW TYPE AREA (FT.^{2})	U VALUE
A-1	1030	Office	2	4767	Asph. Shingles 2384	.29	Vinyl Siding 3599	.24	Wood 108	.60	Exposed 221	.62	Single pane Wood frame 619	.99
A-2	591	Office	1	2448	Asph. Shingles 2448	.27*	15i" Brick 2037	.24	Wood 150	.60	Slab 222	.60	Sgl. Pane Wood Frame 385	.99
A-2	1075	Office	1	3658	Asph. Shingles 3658	.07	8" Block 1940	.39	Wood 112	.60	Slab 298	0.60	Sgl. Pane Mtl. Frame 465	1.10
A-2	300	Admin.	2	8992	Asph. Shingles Blt.-Up 6640	.28 .26	Block-Brick 6712	.51 .33	Wood 252	.60	Slab 412	.60	Sgl. Pane Mtl. 1140	1.10
A-3	851	HQ & Game Rm.	1	4157	Blt.-Up 4157	.22	8"Block 2460	.39	Wood 224	.60	Slab 315	.60	Sgl. Pane Mtl. Frame 432	1.10
A-3	811	Educ. Center	1	3730	Blt.-Up 3730	.16*	12"Block 2883	.36	Wood 170	.60	Slab 370	.60	Sgl. Pane Mtl. Frame 645	1.10
A-4	704	Provost Marshall	2	2525	18"poured concrete 2006	.19	12"Conc. 2497	.32	Wood 100	.60	Slab 150	.60	Sgl. Pane Mtl. Frame 97	1.10
A-4	727	Facil. Eng.	2	4882	Poured con. 4882	.19	Poured conc. 3447	.32	Wood 242	.60	Slab 383	.60	Sgl. Pane Mtl. Frame 372	1.10
B-1	611	Barracks	2	4800	Asph. Sngl. 2400	.36	Vinyl Siding 2963	.24	Wood 76	.60	Exposed 220	.62	Sgl. Pane Wood Frame 642	.99
B-2	847	Quarters	1	6512	Blt.-Up 6647	.24*	9"Block 3484	.35	Wood 157	.60	Slab 441	.60	Sgl.Pane 734	1.10
B-2	849	Quarters	1	7160	Blt.-Up 7160	.24*	8"Block 3568	.35	Wood 156	.60	Slab 506	.60	Sgl.Pane 815	1.10

* WEIGHTED AVERAGE

FIGURE 2

CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS

GROUP NO.	BUILD. NO.	BUILDING USE	NO. OF FLOORS	BUILDING AREA (FT.²)	ROOF TYPE AREA (FT.²)	U VALUE	WALL TYPE AREA (FT.²)	U VALUE	DOOR TYPE AREA (FT.²)	U VALUE	FLOOR TYPE PERIMETER (FT.)	U VALUE	WINDOW TYPE AREA (FT.²)	U VALUE
B-3	321	Family Housing	2	4945	Blt.-Up 2652	.26	Vinyl siding Brick 3638	.26 .29	Wood 224	.50	Slab 257	.60	Sgl.Pane w/storm 542	.50
B-3	439	Family Housing	2	9874	Blt.-Up 5270	.26	Vinyl siding Brick 5553	.26 .29	Wood 280	.50	Slab 461	.60	Sgl.Pane w/storm 1672	.50
B-4	714	Cottage	2	1281	Asph. Shingles 671	.36	Wood Siding 1428	.07	Wood 33	.50	Slab 133	.60	Sgl.Pane 137	1.10
C-1	751	Carpenter	1	1740	Asph. Shingles 2740	.51	Vinyl Siding 2241	.30*	Wood 147	.60	Slab 308	.60	Sgl.Pane Wood Frame 221	.99
C-1	759	Plumbing Repair	1	2336	Asph. Shingles 2336	.47	Wood Siding 2089	.33	Wood 137	.60	Slab 261	.60	Sgl.Pane Wood Frame 195	.99
C-1	1058	Storage Repair	1	2061	Asph. Shingles 2061	.06	Wood Siding 2097	.07	Wood 84	.60	Slab 242	.60	Sgl.Pane 1164	1.10
C-2	804	Garage Repair	1	4790	Blt.-Up 4790	.12	8"Block 3022	.39	Wood 766	.60	Slab 319	.60	Sgl.Pane 1164	1.10
C-2	808	Garage & Repair	1	4814	Blt.-Up 4814	.18	10" conc. 2146	.36	Wood 1120	.60	Slab 321	.60	Sgl.Pane 1106	1.10
C-2	1081	Repair	1	21420	Rolled Asph. 21420	.13	12"Block 7755	.37*	Roll up 4438	1.17	Slab 632	.60	Sgl.Pane 516	1.10
C-2	1082	Repair	1	21140	Rolled Asph. 21140	.13	12"Block 6763	.37*	Roll up 4340	1.17	Slab 632	.60	Sgl.Pane 597	1.10
C-2	1083	Repair	1	10940	Rolled Asph. 21140	.13	12"Block 5267	.37	Roll up 2207	1.17	Slab 407	.60	Sgl.Pane 232	1.10

* WEIGHTED AVERAGE

FIGURE 2 (CONT'D)

CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS

GROUP NO.	BUILD. NO.	BUILDING USE	NO. OF FLOORS	BUILDING AREA (FT.^{2})	ROOF TYPE AREA (FT.^{2})	U VALUE	WALL TYPE AREA (FT.^{2})	U VALUE	DOOR TYPE AREA (FT.^{2})	U VALUE	FLOOR TYPE PERIMETER (FT.)	U VALUE	WINDOW TYPE AREA (FT.^{2})	U VALUE
C-2	1088	Repair	1	17490	Blt.up on 2½" conc. 10716	.85*	8" block/ asbes.sid. 4907 10530	.39 .55	Roll up 2130	1.17	Slab 569	.60	Sgl.Pane 1091	1.10
D-1	586	Mess	2	14816	Asph. Shgl. 14816	.36	Wood Sid. 7938	.33	Wood 189	.60	Slab 566	.60	Sgl.Pane Wood Frame 200	.99
D-1	1016	Mess	1	2408	Asph.Shgl 2408	.25	Vinyl Siding 1767	.27	Wood 108	.60	Exposed 238	.53	Sgl.Pane Wood Frame 300	.99
E-1	750	Ware-house	1	10887	Asph.Shgl 10887	.47	Wood Sid. 4724	.61	Wood 458	.60	Slab 642	.60	Sgl.Pane Wood Frame 273	.99
F-1	845	Day-Room	1	2540	Blt-Up 2540	.22	8" Block 1560	.36*	Wood 168	.60	Slab 234	.60	Sgl.Pane Metal Fr. 405	1.10

FIGURE 2 (CONT'D)

TYPICAL BUILDING SYSTEMS SUMMARY TABLE

GROUP NO.	BUILDING NO.	BUILDING USE	COOLING		HEATING		DOMESTIC HOT WATER		NORMAL PEAK OCCUPANCY	OCCUPANCY SCHEDULE
			SYSTEM TYPE	CAPACITY (TONS)	SYSTEM TYPE	FUEL	SYSTEM TYPE	FUEL		
A-1	1030	OFFICE	N/A	--	FORCED AIR	OIL	250 GAL.	OIL	25	0800-1630 M-F
A-2	591	OFFICE	N/A	--	FORCED AIR/ BASEBD.	OIL/ ELECT.	17 GAL.	1.5 KW ELECT.	20	0700-1700 M-F
A-2	1075	OFFICE	SPLIT DX	10.8	HOT WATER BASEBD.	OIL	140 GAL.	4.5 KW ELECT.	16	0730-1700 M-F
A-2	300	ADMIN.	AIR COOL CHILLER & AHU'S	40	STEAM BASEBD.	OIL	52 GAL.	4.5 KW ELECT.	10	0730-1700 M-F
A-3	851	HQ & GAME RM	PACKAGE DX/COOL TOWER	10	HOT WATER BASEBD.	OIL	52 GAL.	4.5 KW ELECT.	30	HQ: 24 HR, 7 DAY GAME RM: 0730-1700 M-F
A-3	811	EDUC. CENTER	WINDOW UNITS	10.5	HOT WATER BASEBD.	OIL	60 GAL.	3 KW ELECT.	60	0800-1630 MWF 0800-1930 TT
A-4	704	PROVOST MARSHALL	SPLIT DX	7.5	FAN COIL/ BASEBD.	ELECT./ ELECT.	17 GAL.	1.7 KW ELECT.	12	0000-2400 7 DAY
A-4	727	FACIL. ENG.	WTR. COOL CHILLER & AHU'S	10	HOT WATER BASEBD.	OIL	66 GAL.	4.5 KW ELECT.	20	0730-1700 M-F
B-1	611	BARRACKS	N/A	--	HOT WATER BASEBD.	OIL	85 GAL.	OIL	25	24 HR., 7 DAY
B-2	847	QUARTERS	PACKAGE DX	12.5	HOT WATER BASEBD.	OIL	200 GAL.	OIL	17	24 HR., 7 DAY
B-2	849	QUARTERS	PACKAGE DX	14.0	HOT WATER BASEBD.	OIL	70 GAL.	OIL	33	24 HR., 7 DAY

FIGURE 3

TYPICAL BUILDING SYSTEMS SUMMARY TABLE

GROUP NO.	BUILDING NO.	BUILDING USE	COOLING		HEATING		DOMESTIC HOT WATER		NORMAL PEAK OCCUPANCY	OCCUPANCY SCHEDULE
			SYSTEM TYPE	CAPACITY (TONS)	SYSTEM TYPE	FUEL	SYSTEM TYPE	FUEL		
B-3	321	FAMILY HOUSING	N/A	--	FORCED AIR	OIL	264 GAL.*	13 KW ELECT.*	12	24 HR., 7 DAY
B-3	439	FAMILY HOUSING	N/A	--	FORCED AIR	OIL	528 GAL.*	26 KW ELECT.*	24	24 HR., 7 DAY
B-4	714	COTTAGE	WINDOW A/C	2	HOT WATER BASEBD.	OIL	40 GAL.	3 KW ELECT.	4	24 HR., 7 DAY
C-1	751	CAR-PENTER	HEAT PUMP & WINDOW	2	FORCED AIR	OIL	N/A	--	16	0730-1600 M-F
C-1	759	PLUMBING REPAIR	PKG. CX & WINDOW	2.5	FORCED AIR	OIL	52 GAL. 66 GAL.	4.5 KW 4.5 KW	15	0730-1600 M-F
C-1	1058	STORAGE REPAIR	N/A	--	FORCED AIR	OIL	N/A	--	10	0730-1600 M-F
C-2	804	GARAGE & REPAIR	N/A	--	STEAM UNIT HEATERS	OIL	52 GAL.	4.5 KW ELECT.	10	0730-1600 M-F
C-2	808	GARAGE & REPAIR	WINDOW A/C	0.8	STEAM UNIT HEATERS	OIL	6 GAL.	1.5 KW ELECT.	16	0800-1630 M-F
C-2	1081	REPAIR	N/A	--	STEAM UNIT HEATERS	CENTRAL PLANT	66 GAL.	3.6 KW ELECT.	12	0730-1700 M-F
C-2	1082	REPAIR	N/A	--	UNIT HEATERS	PLANT STEAM	104 GAL.	9 KW ELECT.	25	0730-1700 M-F
C-2	1083	REPAIR	N/A	--	UNIT HEATERS	PLANT STEAM	N/A	--	22	0730-1630 M-F

* TOTAL CAPACITY

FIGURE 3 (CONT'D)

TYPICAL BUILDING SYSTEMS SUMMARY TABLE

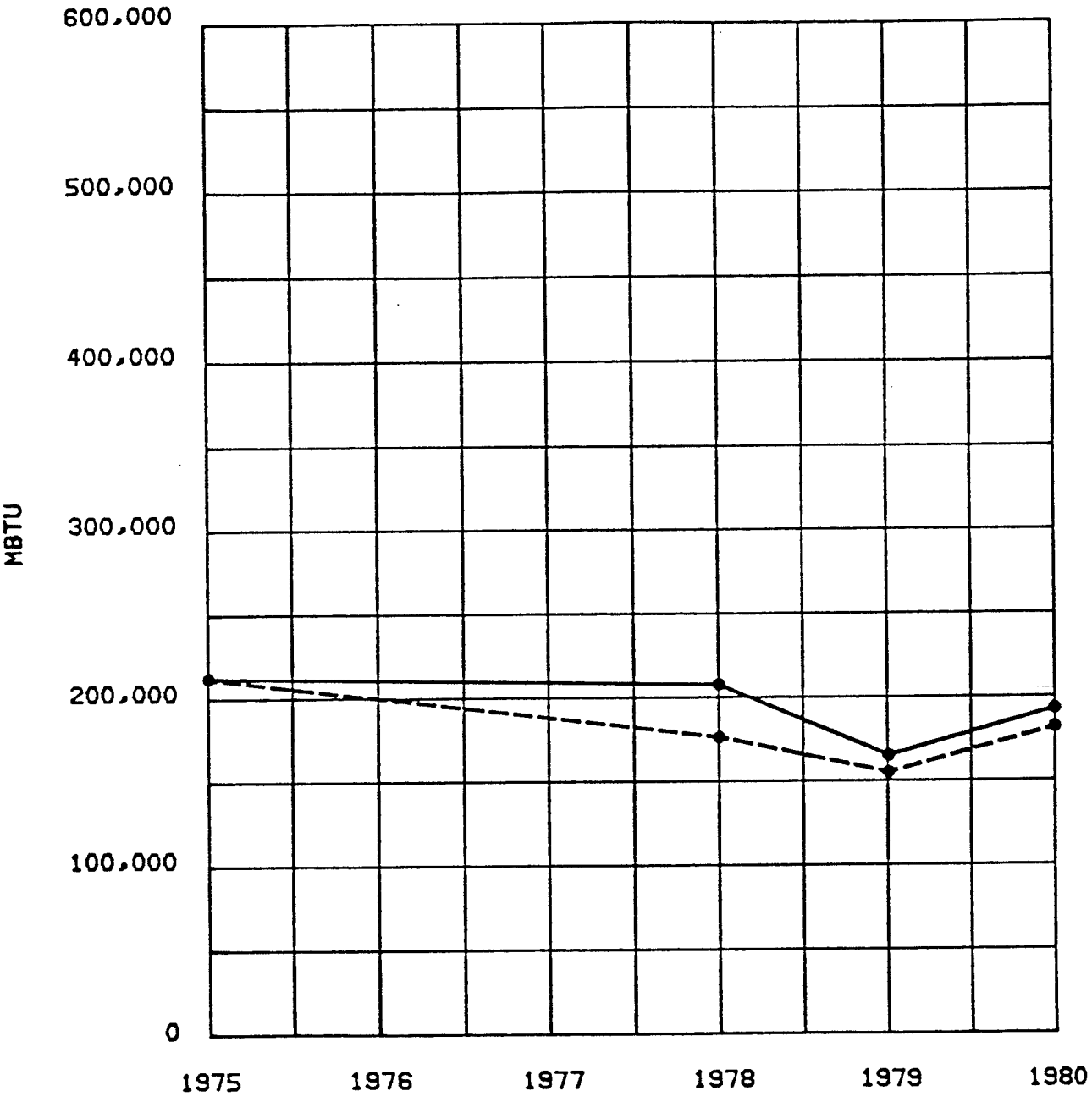
GROUP NO.	BUILDING NO.	BUILDING USE	COOLING		HEATING		DOMESTIC HOT WATER		NORMAL PEAK OCCUPANCY	OCCUPANCY SCHEDULE
			SYSTEM TYPE	CAPACITY (TONS)	SYSTEM TYPE	FUEL	SYSTEM TYPE	FUEL		
C-2	1088	REPAIR	N/A	--	UNIT HEATERS	PLANT STEAM	N/A	--	42	0730-1700 M-F
D-1	586	MESS	PACKAGED DX & WINDOW	36	FORCED AIR & STM BASEBD.	OIL	85 GAL./ 120 GAL.	OIL/30 KW ELECT.	175	0530-1900 7 DAYS
D-1	1016	MESS	N/A	--	FORCED AIR	OIL	500 GAL.	OIL	150	0530-1630 1 WE/MONTH
E-1	750	WARE-HOUSE	SPLIT DX	4.5	HOT WATER BASEBD.	OIL	60 GAL.	2.5 KW ELECT.	13	0730-1600 M-F
F-1	845	DAYROOM	PACKAGE DX	12.2	STEAM BASEBD.	OIL	--	--	10	0700-2300 7 DAY

FIGURE 3 (CONT'd)

BUILDING GROUP ENERGY USAGE 1975

BUILDING GROUP	SAMPLE BUILDING	TOTAL GROUP SQ.-FT.	SAMPLE BUILDING GROUP AVERAGE BTU/FT^2-YR.			TOTAL BUILDING GROUP AVERAGE MBTU/YR.		
			ELECTRIC	FUEL	TOTAL	ELECTRIC	FUEL	TOTAL
A-1	1030	122,462	74,980	97,000	171,979	9,180	11,880	21,060
A-2	591 1075	22,396	227,139	96,625	323,764	5,090	2,160	• 7,250
A-3	811 851	13,188	147,386	86,870	234,243	1,940	1,140	3,080
A-4	704 727	96,604	156,300	52,460	209,010	15,100	5,070	20,190
B-1	611	255,540	69,670	112,143	181,813	17,800	28,660	46,460
B-2	847 849	15,941	113,510	103,420	217,140	1,810	1,650	3,460
B-3	321	195,229	59,380	87,190	146,570	11,590	17,020	28,610
B-4	714	41,091	277,990	139,111	417,100	11,420	5,720	17,140
C-1	751 1058	32,887	51,890	96,431	148,321	1,710	3,170	4,880
C-2	808 , 1082 1083 , 1088	95,738	83,682	89,776	173,458	8,010	8,590	16,610
D-1	1018	46,112	50,380	106,420	156,800	2,320	4,910	7,230
E-1	750	84,527	70,520	90,990	161,500	5,960	7,690	13,650
F-1	845	35,087	85,945	111,260	197,205	3,020	3,900	6,920
BASE	TOTALS -	1,056,790	-	-	-	94,950	101,560	196,540

FIGURE 4



TOTAL MBTU CONSUMPTION

FY-75 THRU FY-80

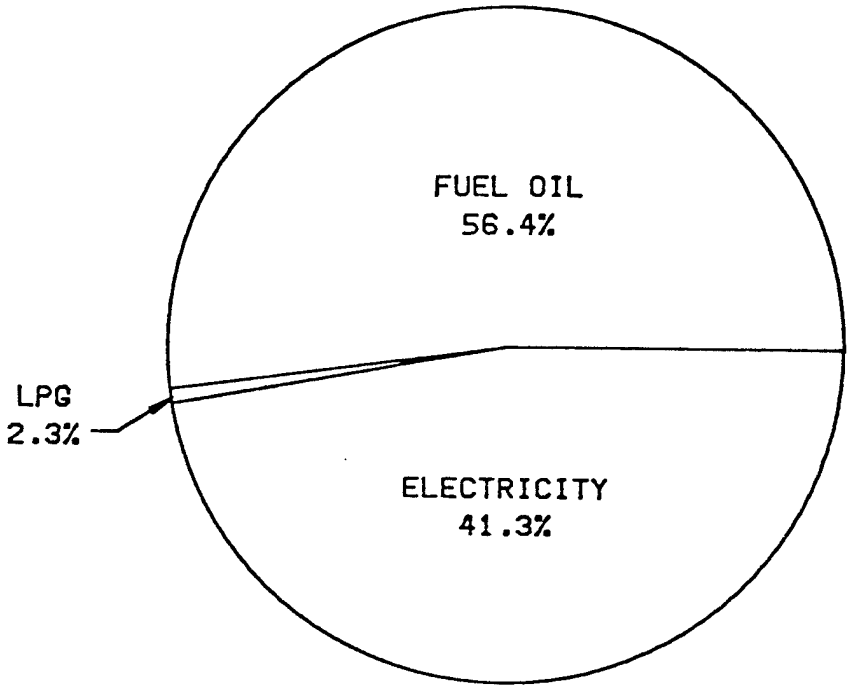
FIGURE 5

TYPE	FY-1975	FY-1978	FY-1979	FY-1980
FUEL OIL* MBTU	114,337	109,940	70,582	90,101
ELECTRICITY KWH MBTU	7,226,400 83,826	8,442,000 97,927	8,274,300 95,982	8,578,400 99,509
LPG MBTU	4,602	2,332	900	1,278
TOTAL MBTU	202,765	210,199	167,410	190,888

* NO.2 AND NO.4 FUEL OIL (FED. RECORDS FOR FY'S 1975, 1979 AND 1980 PRESENTED A COMBINED TOTAL.)

ANNUAL ENERGY CONSUMPTION (MBTU)

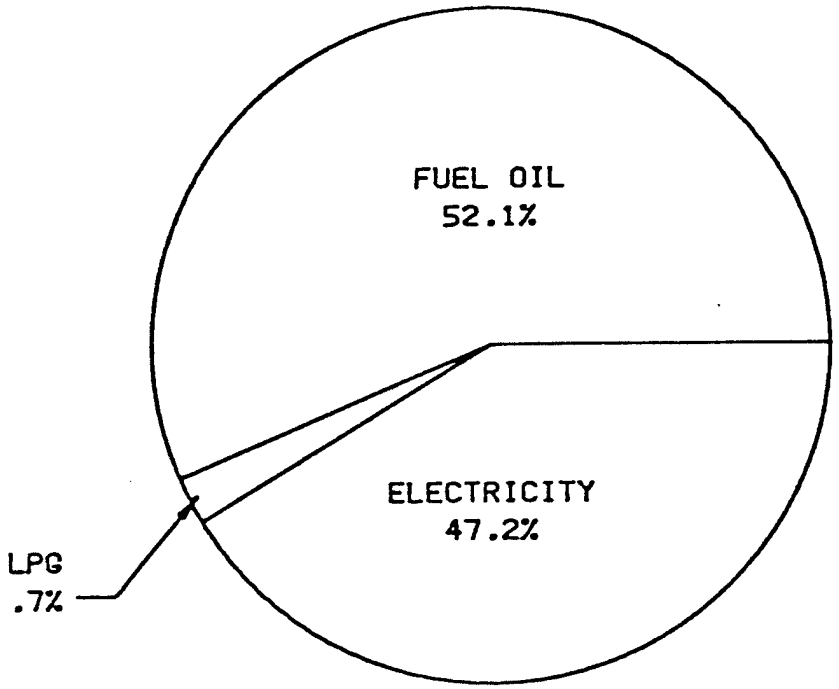
FIGURE 6



TOTAL ENERGY USE BY FUEL TYPE, FORT STORY-FY1975

TOTAL ENERGY USE-202,765 MBTU PER YEAR

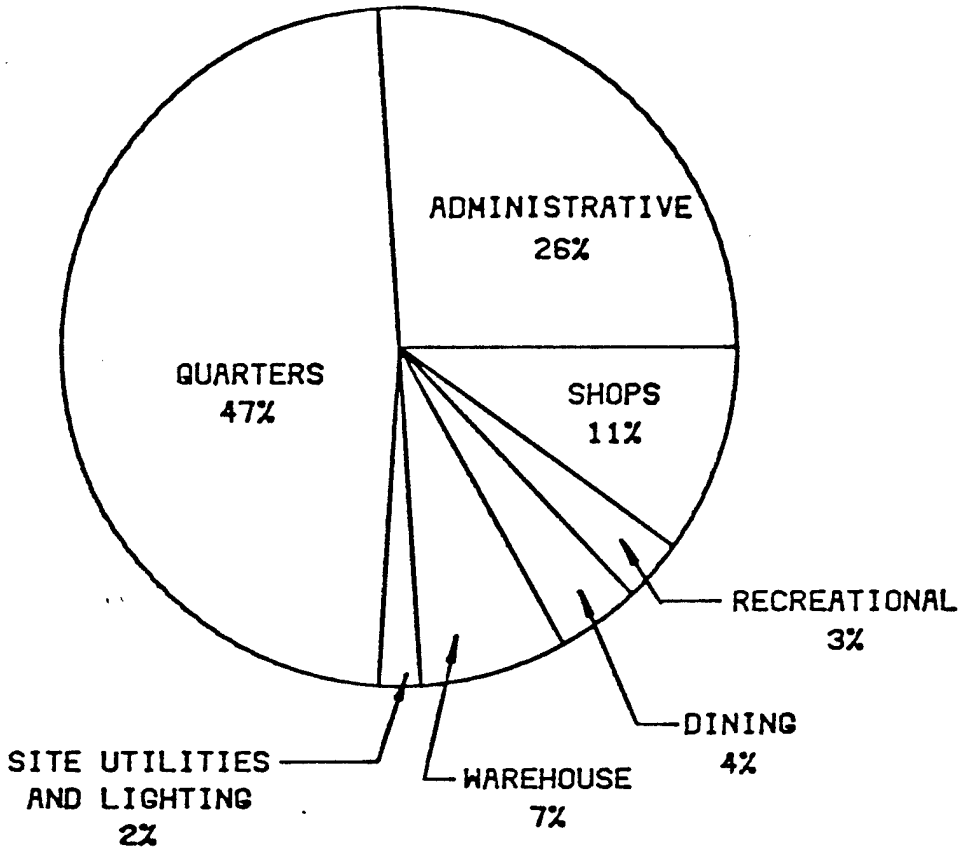
FIGURE 7



TOTAL ENERGY USE BY FUEL TYPE, FORT STORY-FY1980

TOTAL ENERGY USE-190,888 MBTU PER YEAR

FIGURE 8



BUILDING GROUP ENERGY USE

BASE YEAR 1975

FORT STORY

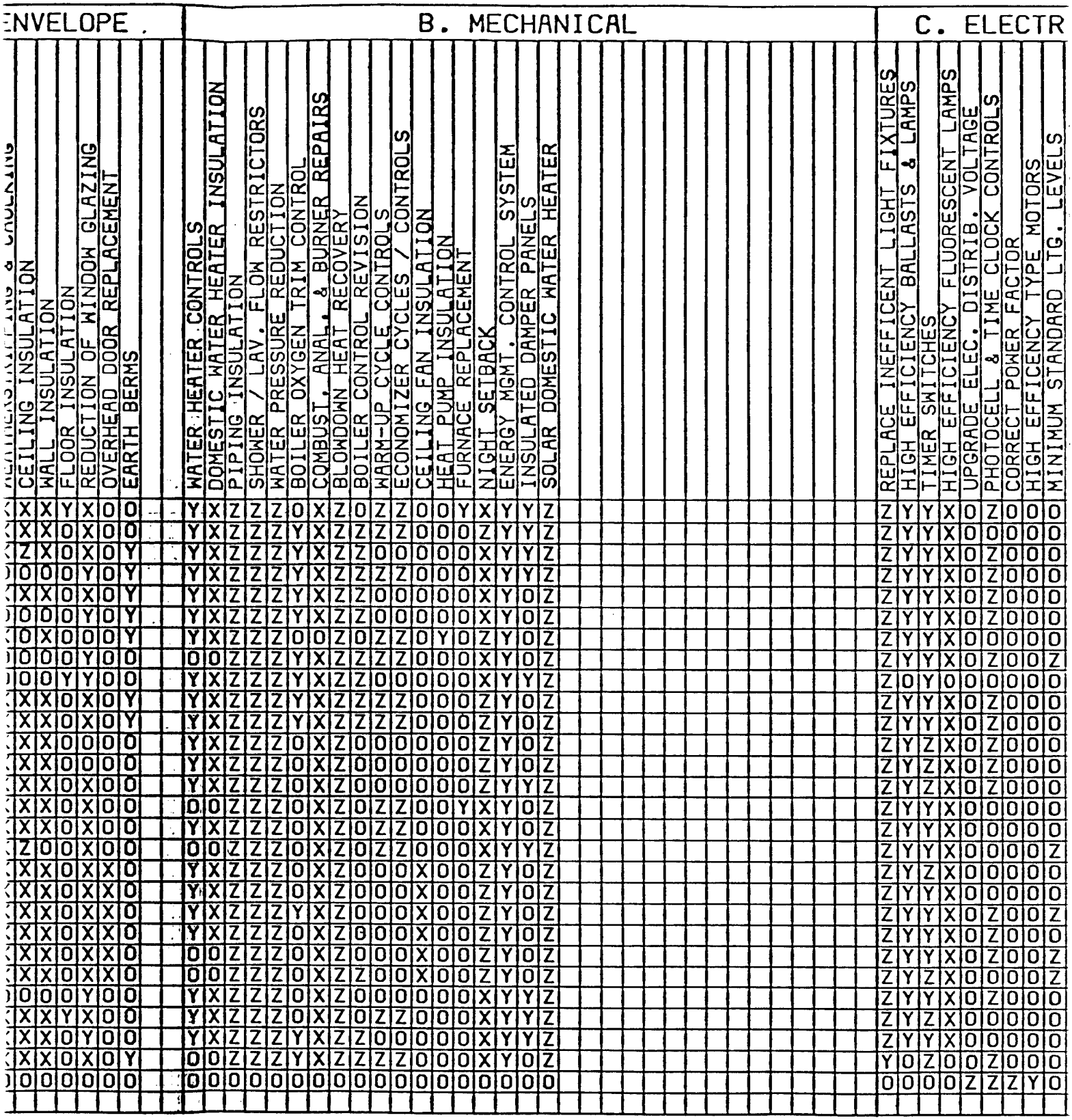
ENERGY ENGINEERING ANALYSIS PROGRAM
CONTRACT NO. DACA65-81-C-0021

LEGEND:

X = GOOD OPTION
Y = FEASIBLE OPTION
(TO RECEIVE PRELIMINARY STUDY)
Z = POOR OPTION
(SEE COMMENTS)
O = NOT APPLICABLE

			A. ENVELOPE											
BUILDING USE GROUP	SUB-GROUP	STUDY BLDG.	EXTERIOR VESTIBULES	INTERIOR VESTIBULES	STORM DOORS	STORM WINDOWS	WINDOW SHUTTERS	WEATHERSTRIPPING & CAULKING	CEILING INSULATION	WALL INSULATION	FLOOR INSULATION	REDUCTION OF WINDOW GLAZING	OVERHEAD DOOR REPLACEMENT	EARTH BERMS
ADMINISTRATION	A-1	1030	Z	O	O	X	O	X	X	X	Y	X	O	O
	A-2	591	Z	Y	Y	X	O	X	X	X	O	X	O	O
		1075	Z	Y	O	X	O	X	Z	X	O	X	O	Y
		300	Z	Y	O	O	O	O	O	O	O	Y	O	Y
	A-3	851	Y	Y	O	X	O	X	X	X	O	X	O	Y
		811	Z	Y	O	O	O	O	O	O	O	Y	O	Y
	A-4	704	Y	Y	O	O	O	X	O	X	O	O	O	Y
		727	Y	O	Y	O	O	O	O	O	O	Y	O	O
QUARTERS	B-1	611	Z	O	O	O	O	O	O	O	Y	Y	O	O
	B-2	847	Y	Y	O	X	O	X	X	X	O	X	O	Y
		849	Y	Y	O	X	O	X	X	X	O	X	O	Y
	B-3	321	Z	O	O	O	O	X	X	X	O	O	O	O
		439	Z	O	O	O	O	X	X	X	O	O	O	O
	B-4	714	Z	O	Y	X	Y	X	X	X	O	X	O	O
SHOPS	C-1	751	Z	Z	O	X	O	X	X	X	O	X	O	O
		759	Z	Z	O	X	O	X	X	X	O	X	O	O
		1058	Z	Z	O	X	O	X	Z	O	O	X	O	O
	C-2	804	Z	Z	O	X	O	X	X	X	O	X	X	O
		808	Z	Z	O	X	O	X	X	X	O	X	X	O
		1081	Z	Z	O	X	O	X	X	X	O	X	X	O
		1082	Z	Z	O	X	O	X	X	X	O	X	X	O
		1083	Z	Z	O	X	O	X	X	X	O	X	X	O
		1088	Z	Z	O	X	O	X	X	X	O	X	X	O
DINING	D-1	586	O	O	O	O	O	O	O	O	O	Y	O	O
		1016	Z	Y	O	X	O	X	X	X	Y	X	O	O
WAREHOUSE	E-1	750	Z	Z	O	Z	O	X	X	X	O	Y	O	O
RECREATION	F-1	845	Y	Y	O	X	O	X	X	X	O	X	O	Y
SITE UTILITIES & LTG.			O	O	O	O	O	O	O	O	O	O	O	O

PRELIMINARY MATRIX - ENE



X - ENERGY CONSERVATION OPTIONS

FIGURE 10

C. ELECTRICAL

REPLACE INEFFICENT LIGHT FIXTURES	HIGH EFFICIENCY BALLASTS & LAMPS	TIMER SWITCHES	HIGH EFFICIENCY FLUORESCENT LAMPS	UPGRADE ELEC. DISTRIB. VOLTAGE	PHOTOCELL & TIME CLOCK CONTROLS	CORRECT POWER FACTOR	HIGH EFFICENCY TYPE MOTORS	MINIMUM STANDARD LTG. LEVELS	SELECTIVE SWITCHING OF LIGHTS	REPLACE INEFFICIENT SITE LIGHTING
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	O	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	O	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	Z	Z	O
Z	O	Y	O	O	O	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Z	X	O	Z	O	O	O	Z	O
Z	Y	Z	X	O	Z	O	O	O	Z	O
Z	Y	Z	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	O	O	O	O	Z	O
Z	Y	Y	X	O	O	O	O	O	Z	O
Z	Y	Y	X	O	O	O	O	Z	Z	O
Z	Y	Z	X	O	O	O	O	O	Z	O
Z	Y	Y	X	O	O	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	Z	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Y	X	O	Z	O	O	Z	Z	O
Z	Y	Z	X	O	O	O	O	Z	Z	O
Z	Y	Y	X	O	Z	O	O	O	Z	O
Z	Y	Z	X	O	O	O	O	O	Z	O
Z	Y	Y	X	O	O	O	O	O	Z	O
Y	O	Z	O	O	Z	O	O	O	Z	O
O	O	O	O	Z	Z	Z	Y	O	Z	X

IONS

(3)

EEA PROJECT SUMMARY

INCREMENT	PROJECT	E/C RATIO	B/C RATIO	INSTALL. COST (#)	ANNUAL SAVINGS (MBTU)	PAYBACK (YRS.)
A	COMBUSTION ANALYSIS AND BURNER REPAIRS	144.5	64.6	103,459	14,949	0.4
A	INSULATED DAMPER PANELS	139.2	59.7	17,863	2,360	0.4
A	CEILING INSULATION	41.3	16.5	125,495	4,924	1.4
A	WEATHER STRIPPING AND CAULKING	33.4	11.9	121,138	3,840	2.0
B	REPLACEMENT OF INEFFICIENT SITE LIGHTING	32.9	4.2	70,158	2,188	4.0
A	FURNACE REPLACEMENT	20.3	8.9	36,859	710	2.7
A	CEILING FAN INSTALLATION	17.3	9.1	45,557	747	2.6
A	DOMESTIC WATER HEATER INSULATION	14.4	2.2	40,294	550	9.6
A X	WALL INSULATION	13.8	5.7	531,726	6,974	4.1
B X	E.M.C.S.	13.4	2.5	1,180,578	14,968	6.3
A	BOILER OXYGEN TRIM CONTROL	9.5	2.5	59,982	542	5.7
	TOTAL:	-	-	2,333,109	52,752	-

FIGURE 11

EEA PROJECT SUMMARY

INCREMENT	PROJECT	E/C RATIO	B/C RATIO	INSTALL. COST (#)	ANNUAL SAVINGS (MBTU)	PAYBACK (YRS.)
G	TIMER SWITCHES	19.0	0.6	39,203	693	7.4
G	REPLACEMENT OF FLUOR. LAMPS	19.0	0.7	42,590	817	9.2
G	HEAT PUMP INSTALLATION	9.9	1.5	7,525	71	14.0
G	REPLACE INEFFICIENT LIGHT FIXTURES	7.1	1.4	30,715	208	7.3
G	EARTH BERMS	6.7	2.9	47,374	300	8.0
G	REPLACE STD. LAMPS & BALLASTS WITH HIGH EFFICIENCY TYPES	3.8	0.3	419,777	1,513	49.0
G	SOLAR DOMESTIC WATER HEATER	1.6	0.4	62,129	93	34.0
G	STORM WINDOWS	1.2	0.4	873,433	992	52.2
G	OVERHEAD DOOR REPLACEMENT	0.8	0.4	490,882	378	66.4
G	WATER HEATER CONTROLS	0.03	0.01	292	0.01	1,978.6

FIGURE 11 (CONT'D)

EEA PROJECT SUMMARY

INCREMENT	* PROJECT	E/C RATIO	B/C RATIO	INSTALL. COST ($)	ANNUAL SAVINGS (MBTU)	PAYBACK (YRS.)
F	REDUCTION OF D.H.W. TEMPERATURE	516.5	52.3	517	2	0.3
F	REDUCTION OF WINDOW GLAZING	79.1	37.5	20	2	0.7
F	REPLACING STANDARD FLUORESCENT LAMPS	39.0	1.4	1,640	64	7.3
F	HIGH EFFICIENCY MOTORS	23.0	1.3	637	14	6.0
F	OVERHEAD DOOR REPLACEMENT	10.7	4.9	3,263	35	5.1
F	PERSONNEL CONSOLIDATION	-	-	-	-	-
F	ENERGY MANAGEMENT STAFF	-	-	-	-	-
F	FUTURE METERING PLAN	-	-	4,791	0	-

* NOTE: SOME INCREMENT (F) PROJECTS HAVE BEEN ANALYZED ON A "PER UNIT" BASIS, SO INSTALLATION COST AND ANNUAL SAVINGS MAY BE MISLEADING. SEE SECTION 3.11 OF THE REPORT NARRATIVE.

FIGURE 11 (CONT.)

ENERGY COST PROJECTION

FISCAL YEAR	ESCALATED FUEL COST ($/MBTU)*	
	ELECTRICITY	#2 FUEL OIL
1980	$3.59	$9.23
1981	4.13	10.61
1982	4.74	12.21
1983	5.46	14.04
1984	6.27	16.14
1985	7.22	18.56

* ESCALATED AS RECOMMENDED BY COE "ENERGY CONSERVATION INVESTMENT PROGRAM GUIDANCE", TABLE #2, AT 15% PER YEAR FOR FUEL OIL AND ELECTRICITY.

EEA044-0782/0101

FIGURE 12

ENERGY PROJECTION SUMMARY

ITEM	MBTU	PERCENT CHANGE
FY 1975 TOTAL ENERGY CONSUMPTION	202,765	100%
A. PAST ENERGY CONSERVATION PROJECTS	(-) 00	(-) 0%
B. ENERGY CONSERVATION PROJECTS UNDER CONTRACT	(-)38,641	(-)19.1%
C. EXISTING OPERATIONAL & MAINTENANCE PROCEDURES	(-) 562	(-) 0.3%
D. DEMOLITION AND SHUTDOWN	(-) 5,674	(-) 2.8%
E. NEW CONSTRUCTION PROJECTS	(+)10,010	(+) 4.9%
*F. RECOMMENDED ENERGY PROJECTS: INCREMENTS (A) & (B)	(-)52,752	(-)26.0%
FY 1985 ENERGY CONSUMPTION PROJECTION	115,146	(-)43.3%

*NOTE: FOR ENERGY SAVINGS RESULTING FROM INCREMENT (F) AND (G) PROJECTS, SEE EEA PROJECT SUMMARY, FIGURE 3-5.

FIGURE 13